



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

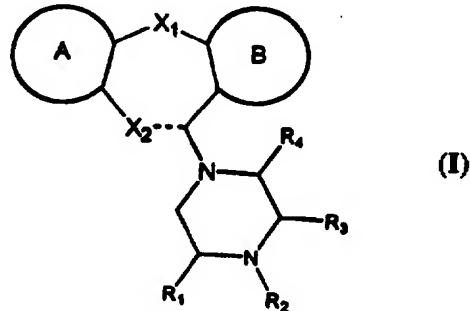
(51) International Patent Classification ⁶ :	A1	(11) International Publication Number: WO 96/18629
C07D 413/04, A61K 31/55		(43) International Publication Date: 20 June 1996 (20.06.96)

(21) International Application Number: PCT/IB95/01111	(81) Designated States: AL, AM, AT, AU, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IS, JP, KE, KG, KP, KR, KZ, LK, LR, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TT, UA, UG, UZ, VN, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG), ARIPO patent (KE, LS, MW, SD, SZ, UG).
(22) International Filing Date: 8 December 1995 (08.12.95)	
(30) Priority Data: 08/354,765 12 December 1994 (12.12.94) US	
(71) Applicant: ALLELIX BIOPHARMACEUTICALS INC. [CA/CA]; 6850 Goreway Drive, Mississauga, Ontario L4V 1V7 (CA).	
(72) Inventors: TEHIM, Ashok; Suite 506, 115 Hillcrest Avenue, Mississauga, Ontario L5B 3Y9 (CA). FU, Jian-Min; 38 Solway Avenue, Brampton, Ontario L6Z 4E3 (CA). RAKHIT, Suman; Unit 20, 1020 Walden Circle, Mississauga, Ontario L5J 4J9 (CA).	

(54) Title: 5-HT2 RECEPTOR LIGANDS

(57) Abstract

Described herein are 5-HT₂ receptor-selective compounds of formula (I), wherein: A and B are independently selected, optionally substituted, saturated or unsaturated 5- or 6-membered, homo- or heterocyclic rings; X₁ is selected from O, S, SO, SO₂, C=O, CH₂, CH-OH, CH-N(C₁₋₄alkyl)₂, C=CHCl, C=CHCN, NH, N-C₁₋₄alkyl and N-acetyl; X₂ is selected from N =, CH₂, CH = and C(O); R₁ is C₁₋₆alkyl optionally substituted with a substituent selected from OH, halo, C₁₋₄alkyl and C₁₋₄alkoxy; and R₂, R₃ and R₄ are independently selected from H and R₁; and acid addition salts, solvates and hydrates thereof. Their use as ligands for serotonin 5-HT₂ receptor identification and in a drug screening program, and as pharmaceuticals to treat indications in which the 5-HT₂ receptor is implicated, such as hypertension, thrombosis, migraine, vasospasm, ischemia, depression, anxiety, schizophrenia, sleep disorders and appetite disorders is also described.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	GB	United Kingdom	MR	Mauritania
AU	Australia	GE	Georgia	MW	Malawi
BB	Barbados	GN	Guinea	NE	Niger
BE	Belgium	GR	Greece	NL	Netherlands
BF	Burkina Faso	HU	Hungary	NO	Norway
BG	Bulgaria	IE	Ireland	NZ	New Zealand
BJ	Benin	IT	Italy	PL	Poland
BR	Brazil	JP	Japan	PT	Portugal
BY	Belarus	KE	Kenya	RO	Romania
CA	Canada	KG	Kyrgyzstan	RU	Russian Federation
CF	Central African Republic	KP	Democratic People's Republic of Korea	SD	Sudan
CG	Congo	KR	Republic of Korea	SE	Sweden
CH	Switzerland	KZ	Kazakhstan	SI	Slovenia
CI	Côte d'Ivoire	LI	Liechtenstein	SK	Slovakia
CM	Cameroon	LK	Sri Lanka	SN	Senegal
CN	China	LU	Luxembourg	TD	Chad
CS	Czechoslovakia	LV	Latvia	TG	Togo
CZ	Czech Republic	MC	Monaco	TJ	Tajikistan
DE	Germany	MD	Republic of Moldova	TT	Trinidad and Tobago
DK	Denmark	MG	Madagascar	UA	Ukraine
ES	Spain	ML	Mali	US	United States of America
FI	Finland	MN	Mongolia	UZ	Uzbekistan
FR	France			VN	Viet Nam
GA	Gabon				

5-HT2 RECEPTOR LIGANDS

This invention relates to compounds that bind selectively to the serotonin receptor 5-HT2, to the preparation of such compounds and to the use of such compounds for therapeutic and drug screening purposes.

5

Background to the Invention

Neuronal and peripheral cell receptors that bind the neurotransmitter serotonin constitute a group of at least seven structurally distinct proteins that can now be produced using recombinant-DNA techniques. These techniques have been applied to construct cell lines that incorporate the serotonin receptor in their membranes, to provide a valuable, regenerable and homogeneous source of substrate with which chemical libraries can be screened to identify potential CNS-active drugs.

15

Recent evidence strongly implicates the serotonin receptor classified as 5-HT2 in the etiology of such medical conditions as hypertension, thrombosis, migraine, vasospasm, ischemia, depression, anxiety, schizophrenia, sleep disorders and appetite disorders. It has been suggested that compounds capable of interfering with the function of this receptor, particularly when there is an excess of circulating serotonin, would be useful to treat these conditions (see U.S.4,931,447 and WO 94/02462). However, the tendency for ligands to bind indiscriminately to various types of dopamine receptors, such as the dopamine D4 and D2 receptors, has made difficult the development of drugs that are 5-HT2 receptor-selective. It would nevertheless be desirable to provide such a compound, particularly so that side effects are minimized during treatment of the conditions noted above.

20

25

It is an object of the present invention to provide a compound having an improved 5-HT2 receptor selectivity profile.

30

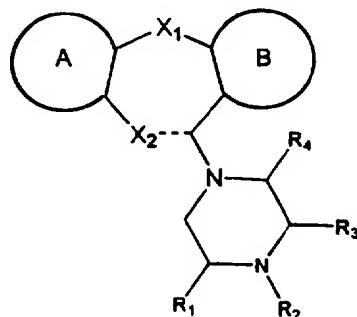
It is a further object of the present invention to provide a pharmaceutical composition comprising a compound of the present invention, as active ingredient.

- 2 -

Summary of the Invention

According to one aspect of the present invention, there is provided a compound of Formula I:

5



10

wherein:

A and B are independently selected, optionally substituted, unsaturated 5- or 6-membered, homo- or heterocyclic rings;

X₁ is selected from O, S, SO, SO₂, C=O, CH₂, CH-OH, CH-N(C₁₋₄alkyl)₂, C=CHCl, C=CHCN, NH, N-C₁₋₄alkyl and N-acetyl;

15

X₂--- is selected from N=, CH₂-, CH= and C(O)-;

R₁ is C₁₋₆alkyl optionally substituted with a substituent selected from OH, halo, C₁₋₄alkyl and C₁₋₄alkoxy; and

R₂, R₃ and R₄ are independently selected from H and R₁;

20

and acid addition salts, solvates and hydrates thereof.

According to another aspect of the invention, there is provided a pharmaceutical composition comprising a compound of Formula I and a pharmaceutically acceptable carrier.

25

In a further aspect of the invention, there is provided an analytical method in which a compound of the invention is used either to distinguish the 5-HT₂ receptor from dopamine receptors such as the D₂ and D₄ sub-types.

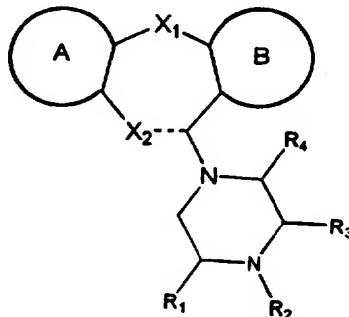
30

These and other aspects of the present invention are now described in greater detail hereinbelow.

- 3 -

Detailed Description and Preferred Embodiments

The invention relates to compounds that bind the serotonin 5-HT2 receptor in a selective manner, relative to dopamine D2 and D4 receptors. In accordance with one of its aspects, the present invention accordingly provides compounds that conform to Formula I:



In embodiments of the invention, R₁ is linear or branched C₁₋₆alkyl optionally substituted with a substituent selected from OH, halo, C₁₋₄alkyl and C₁₋₄alkoxy. Particular embodiments of the invention include those in which R₁ is C₁₋₆alkyl such as methyl, ethyl, linear or branched propyl, butyl, pentyl and hexyl. More particularly R₁ is methyl or ethyl and specifically R₁ is methyl.

20

In embodiments of the invention, R₂, R₃ and R₄ are independently selected from H and R₁. Particular embodiments of the invention include those in which R₂, R₃ and R₄ are independently selected from H and C₁₋₆alkyl. Other particular embodiments of the invention include those in which R₂, R₃ and R₄ are independently H, methyl or ethyl. In specific embodiments R₂ is H and R₃ and R₄ are independently H or methyl. In other specific embodiments R₃ is methyl and R₄ is H.

25

30

In specific embodiments of the invention, the piperazine ring coupled to the tricyclic structure is selected from 3,6-dimethylpiperazine and 2,6-dimethylpiperazine.

- 4 -

The tricyclic function to which the derivatized piperazine is coupled can have various structures and will typically incorporate those found to be important for serotonin 5-HT2 receptor binding. In other words, the tricycles suitable for coupling the derivatized piperazine are those which, when substituted by functions other than the derivatized piperazine, are determined by the assay herein described, to bind the 5-HT2 receptor (preferably the human 5-HT2 receptor) with an affinity not greater than 1 μ M (Ki). In particular, the rings A and B are selected, according to embodiments of the invention, from benzene, pyridine, pyrimidine, pyrazine, pyridazine, pyrole, imidazole, triazole, pyrazole, thiophene, thiazole, furan and pyran. In a particular embodiment, ring A is selected from benzene and pyridine and ring B is selected from benzene, pyridine, pyrimidine, pyrazine, pyridazine, pyrole, imidazole, triazole, pyrazole, thiophene, thiazole, furan and pyran; and is particularly selected from benzene and pyridine. In specific embodiments of the invention, both rings A and B are benzene. It is to be appreciated that when rings A and B are heterocycles, the heteroatoms are shared with the central seven membered ring only when the shared heteroatom is N. Such tricycles are within the scope of the Formula I; one embodiment of which is described by Lednicer et al in The Organic Chemistry of Drug Synthesis, (1992, John Wiley & Sons Inc., New York) wherein ring B is imidazole that is fused to a thiazepine at one of the imidazole nitrogen atoms.

One or both rings A and B may be substituted with from 1 to 3, usually 1 or 2, substituents. When substituted, the substituents are selected from hydroxyl, 25 halo, C₁₋₄alkyl, amino, nitro, cyano, halo-substituted C₁₋₄alkyl, C₁₋₄alkoxy, halo-substituted C₁₋₄alkoxy, C₁₋₄alkoxycarbonyl, C₁₋₄acyl, halo-substituted C₁₋₄acyl, cyclo-C₃₋₇alkyl, thio-C₁₋₄alkylene, C₁₋₄alkylthio, halo-substituted C₁₋₄alkylthio, cyanothio, tetrazolyl, N-piperidinyl, N-piperazinyl, N-morpholinyl, acetamido, C₁₋₄ alkylsulfonyl, halosulfonyl, halo-substituted C₁₋₄alkylsulfonyl, 30 C₁₋₄alkylsulfoxyl, sulfonamido, C₁₋₄alkylseleno, and OSO₃H.

Substitution sites on rings A and B will be limited in practice to the carbon atoms on the ring that are not shared with the central seven membered ring.

- 5 -

For example, a benzene ring can accomodate up to 4 substituents; pyridine, and pyran, rings can accomodate up to 3 substituents; pyrimidine, pyrazine, pyridazine, pyrole, furan and thiophene rings can accomodate up to 2 substituents; imidazole, pyrazole and thiazole rings can accomodate only 1 substituent; and a triazole ring can accomodate no substituents. It is also to be understood that rings A and B may incorporate substituents at nitrogen atoms on the ring that are not shared with the central seven membered ring. For example the NH member of an imidazole ring may be substituted. In particular embodiments, rings A and B are substituted with from 1 to 2 substituents selected from chloro, fluoro, methyl, trifluoromethyl, methoxy, nitro, cyano and methylthio. In particularly preferred embodiments ring A is benzene substituted with 1 or 2 substituents selected from chloro, methyl, nitro and cyano and ring B is benzene substituted with 1 or 2 substituents selected from chloro, methoxy, trifluoromethyl and nitro.

15

In the central, 7-membered ring of the tricycle, X₁, may be any one of CH₂, O, NH, S, C=O, CH-OH, CH-N(C₁₋₄alkyl)₂, C=CHCl, C=CHCN, N-C₁₋₄alkyl, N-acetyl, SO₂ and SO, while X₂--- may be any one of N=, CH₂-, CH= and C(O)-. In a particular embodiment of the invention, X₁ is O, S or NH. In another embodiment, X₂--- is N= or CH=. In a particularly preferred embodiment, X₁ is O, S or NH and X₂--- is N= or CH=. In specific embodiments X₁ and X₂--- are selected to form a seven membered ring selected from oxazepine, diazepine, thiazepine and thiepine.

20

25 In preferred embodiments X₁ and X₂--- together with rings A and B are selected to form a tricycle that is selected from 5H-dibenzo[b,e][1,4]diazepine that is optionally substituted, for example with one of 7,8-dichloro, 7,8-dimethyl, 2-chloro, 3-chloro, 4-chloro, 2,4-dichloro, 4,7,8-trichloro, 2-trifluoromethyl, 1-fluoro, or 2-methoxy; dibenz[b,f][1,4]oxazepine that is optionally substituted, for example with one of 4-nitro, 8-chloro, 4-cyano or 4-chloro; dibenzo[b,f]thiepine that is optionally substituted, for example with one of 2-nitro or 2-chloro; 11H-dibenzo[b,f]thiepine that is optionally substituted, for example with 2-methylthio; and dibenzo[b,f][1,4]thiazepine that is optionally

30

- 6 -

substituted, for example with 8-chloro. In a specific embodiment of the invention, X_1 and X_2 together with rings A and B are form a tricycle which is 8-chlorodibenz[b,f][1,4]oxazepine.

5 In a particular embodiment of the invention, there are provided compounds of formula (I) that bind to the 5-HT2 receptor in a selective manner relative to the dopamine D2 and D4 receptors, including:

8-chloro-11-(3,5-dimethyl-1-piperazinyl)-dibenz[b,f][1,4]oxazepine;

11-(3,5-dimethyl-1-piperazinyl)-dibenz[b,f][1,4]oxazepine;

10 3-chloro-11-(3,5-dimethyl-1-piperazinyl)-5H-dibenzo[b,e][1,4]diazepine;

and

11-(2,5-dimethyl-1-piperazinyl)-dibenz[b,f][1,4] oxazepine.

15 In a more preferred embodiment, there are provided compounds of formula (I) that bind to the 5-HT2 receptor in a selective manner relative to the dopamine D2 and D4 receptors, including:

8-chloro-11-(3,5-dimethyl-1-piperazinyl)-dibenz[b,f][1,4]oxazepine; and

3-chloro-11-(3,5-dimethyl-1-piperazinyl)-5H-dibenzo [b,e][1,4]diazepine.

20 In a more preferred embodiment, there are provided compounds of formula (I) that bind to the 5-HT2 receptor in a selective manner relative to the dopamine D2 and D4 receptors, including:

11-(2,5-dimethyl-1-piperazinyl)-dibenz[b,f][1,4] oxazepine.

25 Acid addition salts of the compound of Formula I include for example those formed with inorganic acids e.g. hydrochloric, sulphuric or phosphoric acids and organic acids e.g. succinic, maleic, acetic or fumaric acid. Other non-pharmaceutically acceptable salts e.g. oxalates may be used for example in the isolation of compounds of Formula I for ligand use, or for subsequent conversion to a pharmaceutically acceptable acid addition salt. Also included within the scope of the invention are solvates and hydrates of the invention.

30 The conversion of a given compound salt to a desired compound salt is

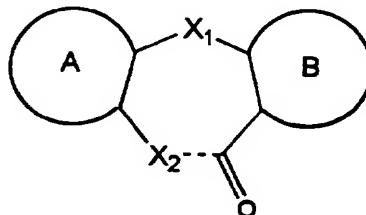
- 7 -

5 achieved by applying standard techniques, in which an aqueous solution of the given salt is treated with a solution of base e.g. sodium carbonate or potassium hydroxide, to liberate the free base which is then extracted into an appropriate solvent, such as ether. The free base is then separated from the aqueous portion, dried, and treated with the requisite acid to give the desired salt.

10 It will be appreciated that certain compounds of Formula I may contain an asymmetric centre. Such compounds will exist as two (or more) optical isomers (enantiomers). Both the pure enantiomers and the racemic mixtures (50% of each enantiomer), as well as unequal mixtures of the two, are included within the scope of the present invention. Further, all diastereomeric forms possible (pure enantiomers and mixtures thereof) are within the scope of the invention.

15 The compounds of the present invention can be prepared by processes analogous to those known in the art. The present invention therefore provides, in a further aspect, a process for the preparation of a compound of Formula I or a salt, solvate or hydrate thereof, which comprises the step of coupling a reagent of Formula A:

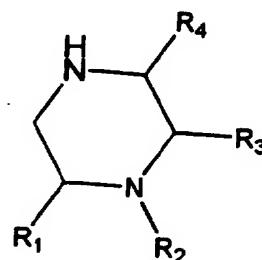
20



25

with a reagent of Formula B:

30

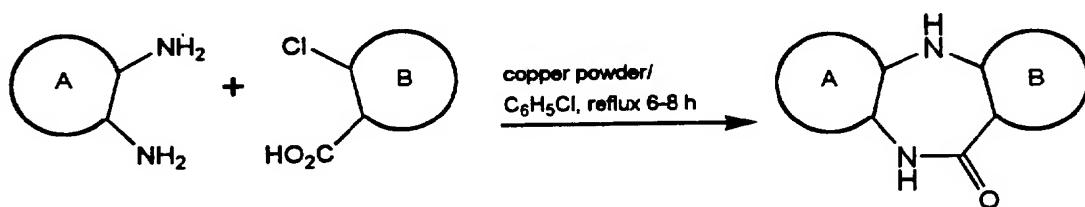


using a Lewis acid such as $TiCl_4$ or $BF_3 \cdot Et_2O$.

- 8 -

5

Reagent (A) can be obtained commercially or can be synthesized using established ring closure procedures. For example, when X_1 is NH and X_{2-3} is N = (a diazepine), reagent (A) may be prepared according to the procedures described by Giani et al (Synthesis, 1985, 550) by refluxing equimolar amounts of 2-chlorobenzoic acid, *o*-phenylene-diamine and powdered copper in chlorobenzene. The following is a schematic representation of the reaction to obtain the diazepine form of reagent (A):

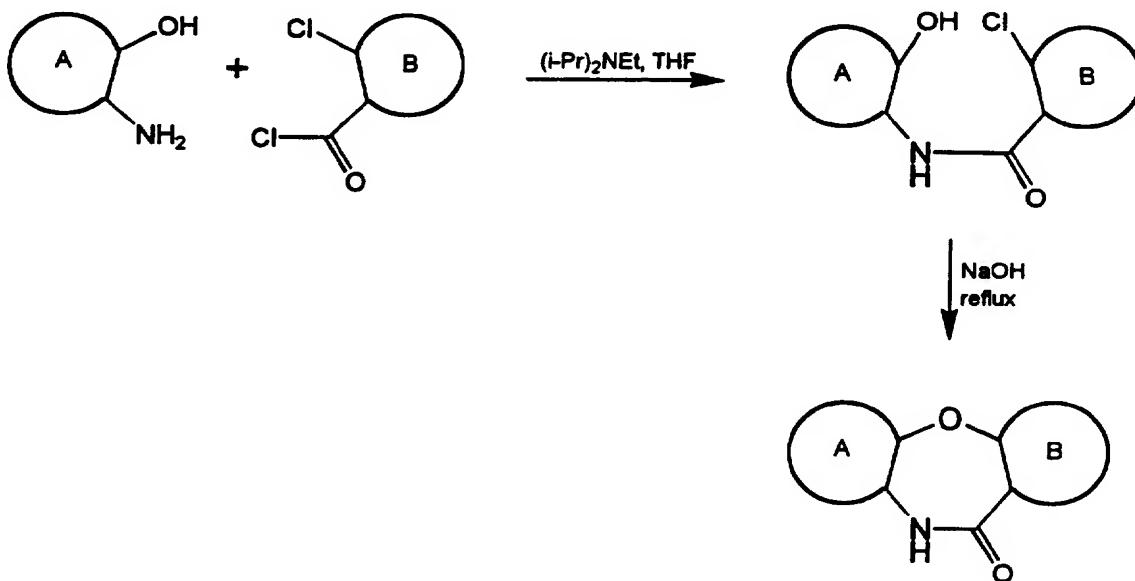


10

15

When X_1 is O and X_{2-3} is N = (an oxazepine), reagent (A) may be prepared according to the procedures described by Klunder (J. Med. Chem. 1992, 35:1887) by condensation of a 2-aminophenol with 2-chloro-5-nitrobenzoyl chloride in THF to afford the corresponding carboxamide followed by refluxing with NaOH for ring closure. The following is a schematic representation of the steps to obtain the oxazepine form of reagent (A):

- 9 -



The thiepine form of reagent (A), i.e. when X₁ is S and X₂₋₋₋ is CH=, may be prepared according to the procedures described by Sindelar et al (Collect. Czech. Chem. Commun, 1983, 48(4):1187). When reagent (A) is an oxepine 5 i.e. when X₁ is O and X₂₋₋₋ is CH₂-, it may be prepared in the manner reported by Harris et al (J. Med. Chem., 1982, 25(7):855); and the corresponding cycloheptene reagent (A) i.e. when X₁ and X₂₋₋₋ are both CH₂, may be prepared as reported by De Paulis et al (J. Med. Chem. 1981, 24(9):1021). The thiazepine reagent (A) may be prepared in a four step process starting from 10 1-bromo-2-nitrobenzene and methyl thiosalicylate. The steps involve coupling; reduction of the nitro group; hydrolysis of the ester group; and finally ring closure.

Reagents of Formula B are commercially available and can also be synthesized 15 using established synthetic techniques from starting materials that are commercially available.

For use as a ligand, the present compounds can be stored in packaged form for 20 reconstitution and use. The compounds can be used to distinguish 5-HT₂ receptors from other receptor types, for example dopamine, glutamate and

- 10 -

5 opioid receptors, within a population of receptors and in particular to distinguish from the dopamine D4 and D2 receptors. The latter can be achieved by incubating preparations of the 5-HT2 receptor and of the D4 and/or D2 receptor with a 5-HT2 selective compound of the invention and then incubating the resulting preparation with a radiolabelled serotonin receptor ligand, such as ^3H -ketanserin. The 5-HT2 and dopamine receptors are then distinguished by determining the difference in membrane-bound radioactivity, with the 5-HT2 receptor exhibiting lesser radioactivity, i.e., lesser ^3H -ketanserin binding.

10 In another embodiment of the invention, the compound is provided in labelled form, such as radiolabelled form e.g. labelled by incorporation within its structure of ^3H or ^{14}C or by conjugation to ^{125}I or ^{123}I . Such radiolabelled forms can be used to directly distinguish between 5-HT2 and dopamine D4 and D2 receptors. Furthermore, radiolabelled forms of the present compounds can be 15 exploited to screen for more potent serotonin 5-HT2 ligands, by determining the ability of the test ligand to displace the radiolabelled compound of the present invention.

20 The binding profile of the present compounds indicates their utility as pharmaceuticals that may be useful for the treatment of various conditions in which the use of a serotonin 5-HT2 receptor ligand is indicated, such as for the treatment of anxiety and schizophrenia.

25 For use in medicine, the compounds of the present invention are usually administered in a standard pharmaceutical composition. The present invention therefore provides, in a further aspect, pharmaceutical compositions comprising an effective amount of a compound of Formula I or a pharmaceutically acceptable salt, solvate or hydrate thereof and a pharmaceutically acceptable carrier.

30 The compounds of the present invention may be administered by an convenient route, for example by oral, parenteral, buccal, sublingual, nasal, rectal or transdermal administration and the pharmaceutical compositions formulated

- 11 -

accordingly.

5 The compounds and their pharmaceutically acceptable salts which are active when given orally can be formulated as liquids, for example syrups, suspensions or emulsions, tablets, capsules and lozenges.

10 A liquid formulation will generally consist of a suspension or solution of the compound or pharmaceutically acceptable salt in a suitable pharmaceutical liquid carrier for example, ethanol, glycerine, non-aqueous solvent, for example polyethylene glycol, oils, or water with a suspending agent, preservative, flavouring or colouring agent.

15 A composition in the form of a tablet can be prepared using any suitable pharmaceutical carrier routinely used for preparing solid formulations. Examples of such carriers include magnesium stearate, starch, lactose, sucrose and cellulose.

20 A composition in the form of a capsule can be prepared using routine encapsulation procedures. For example, pellets containing the active ingredient can be prepared using standard carriers and then filled into hard gelatin capsule; alternatively, a dispersion or suspension can be prepared using any suitable pharmaceutical carrier, for example aqueous gums, celluloses, silicates or oils and the dispersion or suspension filled into a soft gelatin capsule.

25 Typical parenteral compositions consist of a solution or suspension of the compound or pharmaceutically acceptable salt in a sterile aqueous carrier or parenterally acceptable oil, for example polyethylene glycol, polyvinyl pyrrolidone, lecithin, arachis oil or sesame oil. Alternatively, the solution can be lyophilized and then reconstituted with a suitable solvent just prior to administration.

30 Compositions for nasal administration may conveniently be formulated as aerosols, drops, gels and powders. Aerosol formulations typically comprise a

- 12 -

solution or fine suspension of the active substance in a physiologically acceptable aqueous or non-aqueous solvent and are usually presented in single or multidose quantities in sterile form in a sealed container, which can take the form of a cartridge or refill for use with an atomising device. Alternatively, the
5 sealed container may be a unitary dispensing device such as a single dose nasal inhaler or an aerosol dispenser fitted with a metering valve which is intended for disposal after use. Where the dosage form comprises an aerosol dispenser, it will contain a propellant which can be a compressed gas such as compressed air or an organic propellant such as flurochlorohydrocarbon. The aerosol dosage
10 forms can also take the form of a pump-atomizer.

Compositions suitable for buccal or sublingual administration include tablets, lozenges, and pastilles, wherein the active ingredient is formulated with a carrier such as sugar, acacia, tragacanth, or gelatin and glycerine.

15 Compositions for rectal administration are conveniently in the form of suppositories containing a conventional suppository base such as cocoa butter.

20 Preferably, the composition is in unit dose form such as a tablet, capsule or ampoule. Suitable unit doses i.e. therapeutically effective amounts; can be determined during clinical trials designed appropriately for each of the conditions for which administration of a chosen compound is indicated and will of course vary depending on the desired clinical endpoint. It is anticipated that dosage sizes appropriate for administering the compounds of the examples will be in
25 the range from about 0.1 to about 500 mg/kg body weight eg. 0.1 to about 100 mg/kg body weight, and will be administered in a frequency appropriate for initial and maintenance treatments.

30 Example1

11-(3,5-dimethyl-1-piperazinyl)-dibenz[b,f][1,4]oxazepine

To a stirred solution of 10,11-dihydro-dibenz[b,f][1,4]oxazepin-11-one (0.4 g;

- 13 -

1.9 mmol; Aldrich) in dry toluene (20 mL) at room temperature was added 2,6-dimethyl piperazine (0.99 g; 8.7 mmol; Aldrich) followed by the dropwise addition of $TiCl_4$ (1 M in toluene, 2.27 mL; 2.27 mmol). The reaction mixture was refluxed for 2 hours, cooled to room temperature and then poured into an ammonium hydroxide solution (30%, 50 mL). The resulting mixture was extracted with dichloromethane (4x75 mL), and the combined organic phases were then dried (K_2CO_3) and concentrated. Purification of the product was conducted on silica gel using $CHCl_3:MeOH$ (94:6) eluant to give 0.353 g (60%) of 11-(3,5-dimethyl-1-piperazinyl)-dibenz[b,f][1,4]oxazepine as a pale yellow solid; m.p. 112-114°C.

Example 2

8-chloro-11-(3,5-dimethyl-1-piperazinyl)-dibenz[b,f][1,4]oxazepine

The compound 8-chloro-11-(3,5-dimethyl-1-piperazinyl)-dibenz[b,f][1,4]oxazepine was produced in the manner described in example 1, but using the 8-chloro analog of 10,11-dibenz[b,f][1,4]oxazepin-11-one as starting material, for reaction with 2,6-dimethyl piperazine. The 8-chloro compound was produced according to the protocol reported by Coyne et al, in J. Med. Chem., 1967, 10:541. Briefly, this entailed coupling potassium salicylaldehyde with 2,5-dichloronitrobenzene, followed by oxidation to the carboxylic acid, reduction of nitro, and finally ring closure, to yield the desired 8-chloro starting material (m.p. 256-258°C). The 8-chloro starting material was then reacted with 2,6-dimethyl piperazine in the manner described in example 1, and 8-chloro-11-(3,5-dimethyl-1-piperazinyl)-dibenz[b,f][1,4]oxazepine was obtained as a pale yellow solid (51%) ; m.p. 154-56°C.

Example 3

11-(2,5-dimethyl-1-piperazinyl)-dibenz[b,f][1,4]oxazepine

10,11-dibenz[b,f][1,4]oxazepin-11-one (Aldrich) was reacted with 2,5-dimethyl piperazine (Aldrich) in the manner described in example 1, to give 11-(2,5-dimethyl-1-piperazinyl)-dibenz[b,f][1,4]oxazepine as a yellow solid (21%) ; m.p.

- 14 -

46-48°C.

Example 4

3-chloro-11-(3,5-dimethyl-1-piperazinyl)-5H-dibenz[b,e][1,4]diazepine

5

The starting material, 3-chloro-10,11-dihydro-5H-dibenz[b,e][1,4]diazepin-11-one was produced according to the protocol reported by Giani et al, in *Synthesis*, 1985, 550. The 3-chloro lactam was then reacted with 2,6-dimethyl piperazine in the manner described in example 1, and 3-chloro-11-(3,5-dimethyl-1-piperazinyl)-5H-dibenz[b,e][1,4]diazepine was obtained as a brown solid (55%) ; m.p. 132-34°C.

Example 5

5-HT2 Receptor Binding Assay

15 5-HT2 receptor-binding affinities of the compounds of examples 1-4 were evaluated according to their ability to reduce binding of tritiated ketanserin, a serotonin receptor antagonist. The potency of the test compound to reduce ³H-ketanserin binding is directly correlated to its binding affinity for the receptor.

20 5-HT2 Receptor Preparation

Rat frontal cortex tissue was initially prepared by Analytical Biological Services by the following steps: homogenizing in 10 volumes of 0.32 M sucrose at 4°C; centrifuging at 900xg for 10 minutes; centrifuging supernatant at 48,000xg for 20 minutes; suspending pellet in 20 volumes 50 mM Tris HCl, pH 7.7 containing 5 mM calcium chloride; incubating at 37°C for 30 minutes; centrifuging at 48,000xg for 30 minutes; suspending pellets in 2 volumes of buffer and storing in 15 mL aliquots at -70°C. On day of study, tissues were thawed on ice for 20 minutes. The entire pellet was resuspended in 5 mL of buffer (50 mM Tris, 0.5 mM EDTA, 10 mM MgSO₄, 10 uM pargyline, 0.1% ascorbic acid, pH 7.4) at 4°C and sonicated with a Sonifier Cell Disrupter 350 at 8 microtip units for 6 seconds power 80. The protein concentration was determined using the Pierce BCA Assay, adding 1 uL of membrane preparation per sample, in triplicate. Membrane preparations were made in incubation

- 15 -

buffer.

Total ^3H -ketanserin Binding

5 The incubation was started in 12X75 mm polypropylene glass tubes by the addition of 400 μL membrane preparation (100 μg protein) to a solution of 500 μL incubation buffer (50 mM Tris, 0.5 mM EDTA, 10 mM MgSO_4 , 10 μM pargyline, 0.1% ascorbic acid, pH 7.4) and 100 μL ^3H -ketanserin (1 nM final concentration, 85 Ci/mmol, NEN Research Products). The tubes were vortexed and incubated at room temperature for 30 minutes. The binding reaction was stopped by filtering. The samples were filtered under vacuum over glass fibre filters (Whatman GF/B) soaked in 0.3% polyethylenimine (PEI) in 50 mM Tris (pH 7.4) for 2 hours and then washed 3 times with 5 mL ice cold 50 mM Tris buffer (pH 7.4) using a Brandell Cell Harvester. Individual filter disks were put in scintillation vials (Biovials, Beckman). Ready Protein Plus liquid scintilant (5 mL, from Beckman) was added and the vials were counted by liquid scintillation spectrophotometry (Beckman LSC 6500) after equilibrating for three hours at room temperature to give total binding (B_T).

10

15

Non-Specific Binding

20 The incubation was started in 12X75 mm polypropylene tubes by the addition of 400 μL membrane preparation (100 μg protein) to a solution of 500 μL methysergide (30 μM final conc. from 1 mM stock dissolved in DMSO and diluted in incubation buffer, Research Biochemicals Inc.) and 100 μL ^3H -ketanserin (1 nM final concentration, 85 Ci/mmol, NEN Research Products).
25 The tubes were vortexed and incubated at room temperature for 30 minutes. The binding reaction was stopped by filtering. The filters were washed and counted using the same procedure as in the total binding assay described above to give the non-specific binding value (NSB).

30 Displacement Binding

The incubation was started in 12X75 mm polypropylene tubes by the addition of 400 μL membrane preparation (100 μg protein) to a solution of 500 μL test compound (initially 1 and 0.1 M final conc. in incubation buffer) and 100 μL ^3H -

- 16 -

ketanserin (1 nM final concentration, 85 Ci/mmol, NEN Research Products). The tubes were vortexed and incubated at room temperature for 30 minutes. The binding reaction was stopped by filtering. The filters were washed and counted using the same procedure as in the total binding assay described above 5 to give the displacement binding value (B_D).

Calculations

The test compounds were initially assayed at 1 and 0.1 μ M and then at a range 10 of concentrations chosen such that the middle dose would cause about 50% inhibition of 3 H-ketanserin binding. Specific binding in the absence of test compound (B_0) was the difference of total binding (B_T) minus non-specific binding (NSB) and similarly specific binding (in the presence of test compound) 15 (B) was the difference of displacement binding (B_D) minus non-specific binding (NSB). IC_{50} was determined from an inhibition response curve, logit-log plot of %B/ B_0 vs concentration of test compound.

K_i was calculated by the Cheng and Prustoff transformation:

$$K_i = IC_{50} / (1 + [L]/K_D)$$

20 where [L] is the concentration of 3 H-ketanserin used in the assay and K_D is the dissociation constant of 3 H-ketanserin determined independently under the same binding conditions.

Example 6

Dopamine Receptor Binding Assay

25 D2 and D4 receptor-binding affinities of the compounds of examples 1 and 2 were evaluated according to their ability to reduce binding of 3 H-spiperone as compared to the reference compound clozapine. The potency of the test compound to reduce 3 H-spiperone binding directly correlated to its binding 30 affinity for the receptor.

D4 Receptor Preparation

HEK 298 (human embryonic kidney) cells stably transfected with human D4

- 17 -

receptor (D4.2 sub-type) were grown in NUNC cell factories for 5 days (75% confluence) without a media change and removed with versene (approximately 19mg of cells per cell factory tray). The cells were then centrifuged in a Sorval centrifuge for 10 minutes, 5000 rpm (GS3 rotor) and the pellets quickly frozen in liquid nitrogen and stored at -80 °C until used in binding assay. When used in the assay, cells were thawed on ice for 20 minutes and then 10 mL of incubation buffer (50 mM Tris, 1 mM EDTA, 4 mM MgCl₂, 5 mM KCl, 1.5 mM CaCl₂, 120 mM NaCl, pH7.4) was added. The cells were then vortexed to resuspend pellet and homogenized with a Kinematica CH-6010 Kriens-LU homogenizer for 15 seconds at setting 7. Concentration of receptor protein was determined using the Pierce BCA assay.

D2 Receptor Preparation

GH₄C₁ (rat pituitary) cells stably transfected with the human D2 receptor (short isoform) were grown in CO₂ independent media in roller bottles (1500cm²) for 10 days. 100µM ZnSO₄ was added to the cells (the D2 promoter being zinc inducible). After 16 hours, fresh media was added to allow the cells to recover for 24 hours. The cells were harvested using versene and then centrifuged in a Sorval centrifuge for 10 minutes, at 5000 rpm (GS3 rotor). Pellets were quickly frozen in liquid nitrogen and stored at -80 °C until used in the binding assays. When used in the assay, cells were thawed on ice for 20 minutes. Each roller bottle produced approximately 72 mg of protein. 10 mL of incubation buffer was added to the pellets which were then vortexed, resuspended and homogenized with a Kinematica CH-6010 Kriens-LU homogenizer for 15 seconds at setting 7. The receptor protein concentration was determined using the Pierce BCA assay.

Total Spiperone Binding Assay

The incubation was started by the addition of 500µl (50µg protein) membrane homogenate to a solution of 900µl incubation buffer and 100µl (0.25 nM final conc.) ³H-spirone (90 Ci/mmol Amersham diluted in borosilicate glass vial) in 12 X 75 mm polypropylene tubes. The tubes were vortexed and incubated at room temperature for 90 minutes. The binding reaction was stopped by filtering

- 18 -

using a Brandell Cell Harvester. The samples were filtered under vacuum over glass fibre filters (Whatman GF/B) presoaked for 2 hours in 0.3% polyethylenimine (PEI) in 50 mM Tris buffer (pH7.4). The filters were then washed 3 times with 5 mL ice cold 50 mM Tris buffer (pH7.4). Individual filter 5 disks were put in scintillation vials (Biovials, Beckman). Ready Protein Plus liquid scintillant (5 mL, Beckman) was added and the vials counted by liquid scintillation spectrophotometry (Beckman LSC 6500) after equilibrating for three hours at room temperature to determine total binding (B_T).

10 **Non-Specific Binding Assay for D4**

The incubation was started by the addition of 500 μ l (50 μ g protein) membrane homogenate to a solution of 400 μ l incubation buffer, 100 μ l 3 H-spiperone (90 Ci/mmol Amersham diluted in borosilicate glass vial to 0.25 nM final conc.) and 500 μ l (30 μ M final conc.) of fresh dopamine (Research Biochemicals Inc., light 15 protected and dissolved in incubation buffer) in 12 X 75 mm polypropylene tubes. The tubes were vortexed and incubated at room temperature for 90 minutes at which time the binding reaction was stopped by filtering. The filters were washed and counted using the same procedure as in the total binding assay described above to give the non-specific binding value (NSB).

20 **Non-Specific Binding Assay for D2**

This assay employed the same procedures as the non-specific binding assay for D4 with the exception that 2 μ M (final conc.) of (-) sulpiride (Research Chemicals Inc.) was used in place of dopamine.

25 **Displacement Binding Assay**

The incubation was started by the addition to 12 X 75 mm polypropylene tubes 500 μ l (50 μ g protein) membrane homogenate to a solution of 400 μ l incubation buffer, 100 μ l (0.25 final conc.) 3 H-spiperone (90Ci/mmol, Amersham, diluted 30 in borosilicate glass vial to) and 500 μ l of test compound that was prepared from 1 mM stock dissolved in DMSO and stored at -20 °C in polypropylene cryogenic storage vials until dilution in incubation buffer in borosilicate glass vials. The tubes were vortexed and incubated at room temperature for 90 minutes at

- 19 -

which time the binding reaction was stopped by filtering. The filters were washed and counted using the same procedure as in the total binding assay described above to give the displacement binding value (B_D).

5 Calculations

The test compounds were initially assayed at 1 and $0.1\mu M$ and then at a range of concentrations chosen such that the middle dose would cause about 50% inhibition of 3H -spiperone binding. Specific binding in the absence of test compound (B_0) was the difference of total binding (B_T) minus non-specific binding (NSB) and similarly specific binding (in the presence of test compound) (B) was the difference of displacement binding (B_D) minus non-specific binding (NSB). IC_{50} was determined from an inhibition response curve, logit-log plot of $\%B/B_0$ vs concentration of test compound.

15 K_i was calculated by the Cheng and Prustoff transformation:

$$K_i = IC_{50} / (1 + [L]/K_D)$$

where $[L]$ is the concentration of 3H -spiperone used in the assay and K_D is the dissociation constant of 3H -spiperone determined independently under the same binding conditions.

20

Assay results are reported in the following Table:

- 20 -

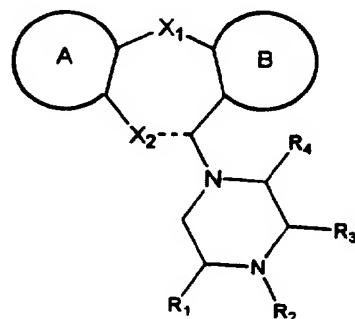
RECEPTOR AFFINITIES (Ki in nM)

COMPOUND	STRUCTURE	D4	D2	5-HT2
clozapine		23	230	7.5
8-chloro-11-(3,5-dimethyl-1-piperazinyl)-dibenz[b,f] [1,4]oxazepine		215	2169	13.4
11-(3,5-dimethyl-1-piperazinyl)-dibenz[b,f][1,4] oxazepine		1097	6326	368
3-chloro-11-(3,5-dimethyl-1-piperazinyl)-5H-dibenz [b,e][1,4] diazepine		2753	14083	24
11-(2,5-dimethyl-1-piperazinyl)-dibenz[b,f][1,4] oxazepine		4538	4893	92

- 21 -

We claim:

1. A compound of Formula I:



wherein:

A and **B** are independently selected, optionally substituted, unsaturated 5- or 6-membered, homo- or heterocyclic rings;

X₁ is selected from O, S, SO, SO₂, C=O, CH₂, CH-OH, CH-N(C₁₋₄alkyl)₂, C=CHCl, C=CHCN, NH, N-C₁₋₄alkyl and N-acetyl;

X₂ is selected from N=, CH₂-, CH= and C(O)-;

R₁ is C₁₋₆alkyl optionally substituted with a substituent selected from OH, halo, C₁₋₄alkyl and C₁₋₄alkoxy; and

R₂, **R**₃ and **R**₄ are independently selected from H and **R**₁; and acid addition salts, solvates and hydrates thereof.

2. A compound according to claim 1, wherein **R**₁ is C₁₋₆alkyl and **R**₂, **R**₃ and **R**₄ are selected from H and C₁₋₆alkyl.
3. A compound according to claim 2, wherein **R**₁ and **R**₃ are C₁₋₆alkyl and **R**₂ and **R**₄ are H.
4. A compound according to claim 3, wherein **R**₁ and **R**₃ are methyl.
5. A compound according to any preceding claim, wherein **X**₁ is O or S.
6. A compound according to any preceding claim, wherein **X**₂ is N= or CH₂.

- 22 -

7. A compound according to any preceding claim, wherein A and B independently are benzene or substituted benzene.
8. A compound according to any one of claims 1-7, wherein A, B, X₁ and X₂ together are selected to form a tricycle which is an optionally substituted dibenz[b,f]-1,4-oxazepine.
9. A compound according to claim 8, wherein said tricycle is a 3-chloro-dibenz[b,f]-1,4-oxazepine.
10. A compound according to claim 8, wherein said tricycle is a 8-chloro-dibenz[b,f]-1,4-oxazepine.
11. A compound according to claim 1, selected from 8-chloro-11-(3,5-dimethyl-1-piperazinyl)-dibenz[b,f] [1,4]oxazepine; 11-(3,5-dimethyl-1-piperazinyl)-dibenz[b,f][1,4] oxazepine; 3-chloro-11-(3,5-dimethyl-1-piperazinyl)-5H-dibenz[b,e][1,4]diazepine; and 11-(2,5-dimethyl-1-piperazinyl)-dibenz[b,f][1,4] oxazepine.
12. A compound according to claim 11, selected from 8-chloro-11-(3,5-dimethyl-1-piperazinyl)-dibenz[b,f] [1,4]oxazepine; and 3-chloro-11-(3,5-dimethyl-1-piperazinyl)-5H-dibenz [b,e][1,4] diazepine.
13. A compound according to claim 11, which is 11-(2,5-dimethyl-1-piperazinyl)-dibenz[b,f][1,4] oxazepine.
14. A pharmaceutical composition, comprising a compound according to any preceding claim in an amount effective to antagonize 5-HT2 receptor stimulation, and a pharmaceutically acceptable carrier.
15. A pharmaceutical composition, comprising a compound according to any preceding claim in an amount sufficient to produce an anti-schizophrenia, and a pharmaceutically acceptable carrier.

- 23 -

16. A pharmaceutical composition, comprising a compound according to any preceding claim in an amount sufficient to produce an anti-anxiety effect, and a pharmaceutically acceptable carrier.
17. The use of a compound according to any one of claims 1-13, for the treatment of a medical condition mediated by 5-HT2 receptor stimulation.
18. The use of a compound according to any one of claims 1-13, for the treatment of schizophrenia.
19. The use of a compound according to any one of claims 1-13, for the treatment of anxiety.

INTERNATIONAL SEARCH REPORT

Int. Application No
PCT/IB 95/01111

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 C07D413/04 A61K31/55

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 C07D A61K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	J. MED. CHEM. (JMCMAR,00222623);86; VOL.29 (10); PP.1877-88, BASF A.-G.;CENT. LAB.; LUDWIGSHAFEN; D-6700; FED. REP. GER. (DE), STEINER G ET AL 'Tricyclic epines. Novel (E)- and (Z)-11H-dibenz[b,e]azepines as potential central nervous system agents. Variation of the basic side chain' see compound 24 ---	1,2,6,7, 14-16
X	J. MED. CHEM. (JMCMAR,00222623);82; VOL.25 (10); PP.1133-40, Lilly Res. Cent. LTD.;WINDLESHAM/SURREY; GU20 6PH; UK (GB), CHAKRABARTI J K ET AL 'Effects of conformationally restricted 4-piperazinyl-10H-thienobenzodiazepine neuroleptics on central dopaminergic and cholinergic systems' see compounds 10,11 and 12 --- -/-	1,2,6, 14-16

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

* Special categories of cited documents :

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *&* document member of the same patent family

1

Date of the actual completion of the international search 20 February 1996	Date of mailing of the international search report 20.03.96
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer Scruton-Evans, I

INTERNATIONAL SEARCH REPORT

Intern. Application No	
PCT/IB 95/01111	

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	COLLECT. CZECH. CHEM. COMMUN. (CCCAK);76; VOL.41 (3); PP.910-22, RES. INST. PHARM. BIOCHEM.;PRAGUE; CZECH., SINDELAR K ET AL 'Neurotropic and psychotropic agents. XCVIII. Neuroleptics of the 10-piperazino-10,11-dihydridobenzo[b,f]thi epin series and related substances: piperazine-alkylated homologs of octoclothepin and methiothepin;5,5-dimethyl-10,11-dihydro-5H -dibenzo[b,f]silepin analog of perathiepin' see compounds IX,XI,XII and XIV	1,2,5,6, 14-16
Y	---	1-16
X	DE-A-31 34 775 (BASF A.-G.;FED. REP. GER.) 10 March 1983	1,2,6,7, 14-16
Y	see example 2	1-16
X	---	1-3,6,7, 14-16
Y	NL-A-6 609 437 (FARMOCHIMICA CUTOLO-CALOSI) 9 January 1967 see Table 1, compounds of formula 6	1-16
X	---	1,2,5-7, 14-16
Y	DE-A-18 01 523 (FUJISAWA PHAMACEUTICAL CO. LTD.) 19 June 1969 see compounds on pages 29,32 and compounds of formula I', I'' and in the scheme on page 11	1-16

INTERNATIONAL SEARCH REPORT

Information on patent family members

Intern. Appl. Application No

PCT/IB 95/01111

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
DE-A-3134775	10-03-83	NONE		
NL-A-6609437	09-01-67	BE-A-	683742	06-01-67
		CH-A-	493467	15-07-70
		CH-A-	496664	30-09-70
		CH-A-	516517	15-12-71
		DE-A-	1670714	03-12-70
		DE-A-	1670814	11-03-71
		FR-M-	5613	11-12-67
		FR-A-	1497538	02-01-68
		GB-A-	1160293	06-08-69
		US-A-	3457264	22-07-69
DE-A-1801523	19-06-69	AT-A,B	306721	15-03-73
		BE-A-	721822	04-04-69
		CA-A-	1017331	13-09-77
		CH-A-	554347	30-09-74
		CH-A-	553212	30-08-74
		CH-A-	537395	13-07-73
		CH-A-	539044	31-08-73
		CH-A-	539056	31-08-73
		FR-M-	8456	10-09-71
		GB-A-	1250792	20-10-71
		NL-A-	6814346	09-04-69
		SE-B-	361665	12-11-73
		US-A-	3928356	23-12-75